Syllabus and Course Description
Geophysical Geodesy
GPH 411/611

Instructor Name: Bill Hammond
Office Location: SEM 315
Phone Number: 784-6436
Email Address: *whammond@unr.edu*

Course Description:
This course develops the basic concepts and practice of geophysical geodesy, with emphasis on the quantitative description and modeling of deformations of the solid Earth using precise space-based methods such as GPS. Topics include measurement of surface deformations associated with the earthquake cycle, tectonic plate boundary deformation, volcanoes, subsidence, etc. The curriculum will emphasize the relationships between data and models, recent seismic events, and provide an overview of recently constructed geodetic facilities such as the EarthScope Plate Boundary Observatory. The course is appropriate for graduate students and upper division undergraduates (400/600 level, 3 units).

Course Prerequisites: GPH 333 (or permission from instructor)

Required texts, course materials:
No required text or materials

Course Objectives and/or learning outcomes:
Students will acquire knowledge of modern space geodetic technologies (e.g. GPS) precision and capabilities. They will develop skills in building quantitative computer models that explain geodetic data in terms of solid Earth processes.

Description of Assignments: (exams, quizzes, projects, papers)
Readings
Problems sets
1 Mid-term
Project involving computer programming/data analysis
Graduate students do more sophisticated project and give an oral presentation.

Grading Criteria:

Participation - Includes attendance, contribution to class discussions	(10%/10%).
Problem sets - Graded according to completeness, neatness, correctness	(30%/25%).
Mid-term - Graded	(20%/10%).
Projects - Graded on completeness, neatness and quality	(25%/25%).
Presentations - Graded on preparation, clarity, diction, content	(0%/15%).
Final Exam	(15%/15%).
	(undergrad/grad %)

Assignments handed in late will be accepted at reduced value towards grade.

Additional Requirements for 611 credit:
Students who take this course at the graduate level will be required to do a more sophisticated numerical analysis or modeling project and present the outcome of this project orally to the class at the end of the term.

Academic Dishonesty Policy:
Students are expected to adhere to the ethical code as described in the UNR Student Handbook. This code specifies that with enrollment, an individual commits to the principles embodied in the code. Academic dishonesty in any form is unacceptable. In the event of an academic dishonesty issue, the procedures for addressing the issue are outlined in the University's "Academic Dishonesty Procedures", which can be obtained from the Director of Student Judicial Affairs in the Jones Visitor Center.

Students With Disabilities
Students with disabilities or who require special accommodations should notify the instructor at the beginning of the course so that suitable arrangements may be made.

Course Calendar/Topics Outline:

I. THEORETICAL BASICS & TOOLKITS

week 1. Geodetic Lexicon
- Class Logistics
- Pillars of geodesy - what we *won't* cover in this class
- Earth's gravity field and geoid
- Datums
- latitude, longitude
- What is height?

Problem set #1 - getting started with Matlab

week 2. Reference Systems, Frames and Transformations
- Reference frame basics (CM, CE, CF, etc.)
- Helmert 7-parameter transformations: Rotation, Translation, Scale
- Euler Rotations: A plate moving on a sphere
- Coordinate Transformations: X,Y,Z to N,E,U
- Uncertainty and Covariance
- Models and Data

Problem set #2 - solve for rates from time series

week 3-4. Fundamentals of Deformation: Strain, Stress & Elasticity
- Tensors, 2 and 3 dimensions
- Shear and bulk moduli
- Other rheologies, e.g. viscoelasticity
- Stress/Strain Invariants
- World Stress Map
- Strain Maps

Problem sets #3 - solve for strain rates from velocity fields.

week 5.-6. The GPS/GNSS system. Flavors of GPS.

Data content and structure

Theory, model equations.

Properties of system, Orbits, Baselines, Triangles.

Methods and uses.

Problem set #4 assigned.

mid-term Oct. 1.

II. CURRENT TOPICS IN GEODESY

week 7-8. EarthScope, The Plate Boundary Observatory/GGOS

Online tour of the facilities

Data products, access

Volcano Geodesy

Western US/Basin and Range tectonic deformation,

Readings and Discussion

Recent large earthquakes and swarms

Deadline: Graduate Student Projects must be defined.

mid-Oct. Field Trip to EarthScope Instrumentation

III. TECTONICS AND THE EARTHQUAKE CYCLE

week 8-9. Plate Motions and Plate Boundary Zones

Tectonics, rigidity of plates

Rates of motion, uncertainties

Distributed continental deformation

Continuum vs. block representations

Stress in the lithosphere, boundary vs. gravitational stress

Problem set #5

week 9-10. The Earthquake Cycle – Interseismic Deformation

Observations, Geology, GPS, InSAR, Western U.S. perspective

Fault models

Savage equations

The San Andreas fault

Fault Creep

Problem set #6

week 11. The Earthquake Cycle – Coseismic Deformation

What happens during an Earthquake?

The Earthquake as seen with Seismology vs. Geodesy

Using data to infer the properties of an earthquake model

Okada functions.

Geodetic case studies:

The 1906 San Francisco Earthquake
The February 2008 Wells NV earthquake
2008 Mogul Swarm
The coming big ones (Cascadia, Southern California, etc.)
Periodic, Time predictable and slip predictable models.
Episodic Tremor and Slip in Cascadia and elsewhere

week 12. The Earthquake Cycle - Post-seismic deformation
Observations
Transient vs. secular deformation
Rheologies: brittle vs. viscous-viscoelastic
Models, historical development

week 13. Interferometric Synthetic Aperture Radar (InSAR)
What is it? Strengths, Weaknesses
Coseismic deformations
Other Uses, e.g. subsidence

week 14. Graduate Student Class presentations

week 15. Guest Lectures
What's the Professor been up to?
(e.g. Tsunami Warning, Real-Time GPS, Colorado Plateau)

week 16. Open for catch up.